



Australian Bureau of Statistics

1350.0 - Australian Economic Indicators, 1995

ARCHIVED ISSUE Released at 11:30 AM (CANBERRA TIME) 10/02/1995

Feature Article - A Guide to Interpreting Time Series - Monitoring Trends: An Overview

INTRODUCTION

Regular readers of Australian Bureau of Statistics (ABS) publications will have noticed that the main features and commentaries sections concerning most time series are increasingly emphasising the trend series rather than the seasonally adjusted or original data. The smoothing techniques used to produce ABS trend estimates allow those estimates to be published with a high degree of confidence in their statistical usefulness. The ABS is progressively placing emphasis on the trend series in the main features of all major economic indicator publications.

This article briefly explains why, and indicates how, these trend estimates may be used more effectively for informed decision making. It also provides some guidelines for interpreting the most recent trend estimates, which are subject to subsequent revision. The contents of this article have also been published in an information paper (1348.0) with the same title. For a more detailed discussion of this aspect and other related issues refer to the companion Information Paper **A Guide to Interpreting Time Series : Monitoring 'Trends'**, 1993 (1349.0). Details concerning ABS trend procedures were previously discussed in the Information Paper **A Guide to Smoothing Time Series : Estimates of 'Trend'**, 1987 (1316.0) and its companion paper **Time Series Decomposition : an Overview**, 1987 (1317.0).

The ABS will continue to provide seasonally adjusted and original series. Nevertheless, the ABS advises that its trend estimates are the better guide to the substantive movements, i.e. non-irregular and non-"seasonal" movements, in all areas covered by its time series collections, and are generally more suitable for most business decisions and policy advice.

While the trend estimates are generally reliable, there are some instances where the usefulness of trend estimates is reduced by the high degree of irregularity contained in the original and seasonally adjusted series, or when the time series characteristics of the original data have changed abruptly. In these instances particular care must be exercised in attempting to discern any trend behaviour. This difficulty exists regardless of whether the ABS trend estimates are used, or the original or seasonally adjusted series. This is because the problem(s) is likely to exist in all three forms of the indicator, though the problem is generally less in the trend estimates.

The nature of time series

The time series collected by the ABS are statistical records of various activities measured at more or less regular intervals of time, over relatively long periods. They are collected on this basis to assist understanding of the current situation, enabling the topical estimates to be placed into a meaningful historic perspective. This feature thereby permits analysts to discern whether the current situation is improving, deteriorating or staying much the same as before.

THE ORIGINAL DATA AND ITS COMPONENTS

At any time an observation in an original series is the combined impact of three distinctly different notional influences. Each of these influences contributes to the movements of the original series. The relative contribution of each influence varies between series, and indeed over time, for an individual series. These influences have different characteristics which enable them to be identified and quantified when sufficient data are available. The three influences on the original series are the systematic calendar related effects, trend behaviour, and residual/irregular factors.

The systematic calendar related influence represents the combined effect of seasonal cycles, trading or working-day patterns, pay-day effects and the systematic impact of moving holidays. Each of these above influences has one characteristic in common - they operate in a sustained and systematic manner that is calendar related. Taken together they are known broadly as the 'seasonal' effects.

There is a stark contrast between the seasonal effects and the residual/irregular factors. This latter influence gives rise to volatility in series because it represents the hiccups and transient activities that occur in socioeconomic behaviour, as well as unavoidable aspects of the data collection process such as sampling error, and non-sampling statistical error. In many situations, the irregular factors are thought of as distractions, masking the underlying behaviour of the series. In general they are not usually regarded as relevant determining factors for business decisions or policy advice.

The trend of a series represents the fundamental or essential direction of the series. It captures the longer-term direction of the series as well as the various medium term 'business cycles'. In contrast to the residual/irregular factor, the trend does not chop and change direction from period to period. Trend movements are generally quite smooth and gradual by comparison. Also, in contrast to the seasonal effects, the trend's turning points are not calendar related, for while the turning points of the 'business cycles' recur, they do not necessarily do so at fixed calendar intervals. Consequently, another interpretation of the trend is that it represents the underlying direction of the series, excluding seasonal effects and residual/irregular factors.

From the original data it is generally difficult to discern the trend behaviour, because the various seasonal effects mask the relatively subtle changes of the trend. Consequently, seasonal effects are removed from many series, thereby producing seasonally adjusted series. It is crucial to note that the seasonally adjusted series is a combination of both the underlying trend and all the irregular effects. Seasonal adjustment does not remove irregularity.

THE IRREGULARITY OF SEASONALLY ADJUSTED CHANGES

Since the seasonally adjusted series is composed of both the trend and residual/irregular factors it is important to determine which of the two generally accounts for the period to period movements of the seasonally adjusted series. If (as turns out to be the case for many series) these period movements are mainly due to the residual/irregular factors then movements of the seasonally adjusted series should not be regarded as reasonable indicators of the underlying behaviour of the series. The Australian Economic Indicators feature article 'Smarter Data Use', March 1992, illustrated how poorly the period to period movements in the seasonally adjusted series reflected the underlying trend behaviour, for a range of topical major economic indicators. Irregular factors outweighed changes in the trend, for between 50 per cent and 90 per cent of all the movements observed in the seasonally adjusted series over the last 5 years.

In the ABS' experience, many seasonally adjusted series exhibit a high degree of irregularity in their period to period movements. Consequently, movements in seasonally adjusted series are not in their own right useful indicators of trend behaviour.

MISLEADING TREND INDICATORS

The volatility of seasonally adjusted series, that occurs as a consequence of the irregular influences remaining in it, is easily observed by graphing the series. A number of quite simple techniques have often been used in attempts to transform seasonally adjusted data into an indicator which purports to show the relatively subtle changes in the underlying trend. Common transformations of the seasonally adjusted series are: growth over a year, moving annual sums, annual growth rates, growth in the three months to, and various forms of 'annualising'. Unfortunately, despite being intuitively appealing, many of these transformations produce misleading indications of trend behaviour. They delay the detection of trend turning points and distort their shape and level, and in some cases increase the irregularity inherent in the seasonally adjusted data.

For further discussion of this aspect refer to the **Australian Economic Indicators** (1350.0) feature article 'Picking Turning Points in the Economy.' April 1991, and to the information paper, 1349.0.

ABS TREND ESTIMATES

To avoid the difficulties raised by the above transformations the ABS produces explicit trend estimates that can be monitored with each additional observation to the series, thereby aiding more timely and informed decision making.

These trend estimates are produced by smoothing the seasonally adjusted series using a statistical procedure designed to minimise distortion of trend level, turning point shape, and timing of turning-points. It is based on Henderson moving averages. It is important to note that these moving averages are centred on the point of time at which the trend is being estimated, and thus there is no distortion of the timing of turning points.

REVISION OF TREND AND SEASONALLY ADJUSTED ESTIMATES

For recent data points, however, insufficient data exists to use centred Henderson moving averages to calculate the trend values. At the end of the series trend estimates are consequently derived by using alternative moving averages (which are not centred) that approximate the smoothing properties of the Henderson moving average. Revision to the trend estimate as subsequent data becomes available is therefore unavoidable, with the last three trend estimates being most prone to revision. This revision problem at the end of the series is referred to as the 'end-point problem'.

Initially it may appear that the seasonally adjusted series are subject to less revision than trend series, but this is not so. A similar end-point problem affects the estimation of 'seasonal' adjustment factors, which in turn influences the stability of the seasonally adjusted series as additional data is brought into the adjustment process. However, in this case, instead of noticeably affecting just the last few observations, as in the trend case, it is the estimates of the last few years that are subject to revision. Generally, five or more years worth of seasonally adjusted figures are subject to revision. This feature of seasonally adjusted series is not as obvious as the revision to the trend estimates because the former revisions are generally made after a year's additional data become available, while the latter are revised with each additional observation.

Apart from the last few estimates which can be affected when new data become available, the

trend series is generally a very robust series. In fact, even when a seasonally adjusted series is revised, it turns out that the impact on the corresponding trend series is usually quite minimal.

In general, the degree of revision of the seasonally adjusted and trend series is directly related to the extent of irregularity in the original series. Details concerning the expected degree of general revision to a particular ABS series are available on request.

In exceptional cases, the task of estimating trends is made difficult when the original series alters its normal characteristics by displaying an extraordinarily large irregular movement, an abrupt jump in the trend level, and/or a new seasonal pattern. In these circumstances, the preliminary trend estimates can be subject to larger than normal revision. Where appropriate, the ABS will provide warnings about such features of the original data and their impact on the trend series.

Generally, it is only the last three trend estimates that are subject to noticeable degrees of revision, with the last estimate experiencing the greatest revision. This revision feature of the trend does not, however, necessarily mean that the pinpointing of turning-points is subject to revision. For example, the various revised trend estimates of gross domestic product, GDP(A), at constant prices, all indicated a growth turning-point at March quarter 1989, even though the subsequent trend estimates revised the level and degree of sharpness of the turning-point by various degrees.

There will, however, be circumstances where claims about the presence of a current trend turning-point should not be made until a few preliminary trend movements corroborate its existence. This is especially the case for seasonally adjusted series that are known to be highly erratic. In cases such as these, and many ABS major economic indicators fall into this category, an analysis of how sensitive the current trend estimates are to additional data can be useful. Such analysis is referred to as 'sensitivity analysis'.

Some scenarios that may be considered in a sensitivity analysis include:

- What value must the next available seasonally adjusted figure be to result in no revision to the current trend figure?
- What value must the next seasonally adjusted figure be to maintain the current trend growth rate, or cause a current turning-point?
- What revision would happen to the current trend point if the next seasonally adjusted figure grew (or fell) by a typical or nominated amount, say its average percentage growth (or fall) over the last few years?

All of these questions (and many others) can be answered, and can be very useful in helping decide whether the current trend point could be revised enough to alter actions that are likely to be based on it. The main features and commentaries of ABS publications will mention when trend figures appear to be particularly sensitive to revisions. Regardless of the scenario considered, however, the future value of the seasonally adjusted figure cannot be known in advance.

In the above sensitivity analyses, each of the scenarios considered involved conditional statements, that is, 'this is what the trend series would be if the seasonally adjusted series was such and such next period, all other factors constant.' In such an analysis no likelihood of the particular scenario becoming an outcome is given. That aspect is left to the analyst to determine, given that additional information or hypotheses may be available to the analyst.

However, general probability statements concerning the trend's revisions may be useful to

analysts and the ABS is investigating ways in which this may be achieved. Since the revision of the trend series is directly related to the extent of irregular variation present in the original and seasonally adjusted series, the ABS is investigating ways in which information about the varying degree of irregularity for various calendar months and years can be used to construct a probability revision region about the preliminary trend estimates. For a given probability this revision region would expand or contract about the preliminary trend estimates according to whether the period being immediately approached was a more or less irregular period relative to those recently past. The revision region could also vary according to whether the degree of irregular variation was generally increasing or decreasing over the local period being smoothed.

COMPARISONS BETWEEN DIFFERENT TREND SERIES

Care should be taken when comparing the trend estimates from different data series. Trend series are smoother than either the original or seasonally adjusted series. Because of this, a correlation between two trend series may appear strong, but this does not necessarily indicate a causal or meaningful relationship exists between them, once all the relevant factors are considered. Moreover, when a strong relationship between the trend behaviour of the two series exists, it should not be interpreted as meaning that the same strong links will necessarily exist within the calendar related, and irregular aspects of the series. For complex analyses, comparing several data series, the form of the data to be examined (trend, seasonally adjusted or original data) should be chosen carefully, after considering the purpose of the analysis. The ABS will continue to publish original and seasonally adjusted data, as well as trend series.

This page last updated 23 December 2009

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